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LIGHT *VERSUS* HEAVY CABLES.

A SETTLEMENT of this much vexed question seemed at hand, and provided all went well, we expected to hear of the submersion of a light cable of the latest improved type before the autumnal gales of the present year had set in. In consequence, however, of the insufficient pecuniary support accorded to the enterprise, the promoters of the Light Cable Company have, for the present at least, given up the idea of laying a new cable, and the question will remain an open one.

Although the leading engineers have, we believe, hitherto taken a decidedly adverse view as to the practicability of laying and maintaining a light cable, yet the fact that such thoroughly competent and experienced men as Sir Samuel Canning and Mr. Robert Sabine, had undertaken the engineering work for the Company is a sufficient guarantee of the possibility of completing a cable of the light type.

The causes which have hitherto delayed the submersion of a light cable are not far to seek. Primarily the reason seems to be that no sufficient proof has as yet been applied to show the durability of hemp, tarred or otherwise, when exposed to the continued action of sea water for a lengthened period. This doubt is now considered to be at rest, and it is confidently stated that tarred Manilla hemp is practically indestructible in sea water. Nevertheless, this indestructibility has been disputed by some men eminently qualified to give opinions on the subject, Sir James Anderson among others.

The recovery of a portion of the 1858 Atlantic Cable last year, from mid ocean, in good preservation after a submersion of 16 years, is certainly an argument in favour of light cables, but it is also favourable to the iron sheathed type of cable; for the iron wires, as well as the hemp, were found in good condition.

Provided the core of a deep sea cable remained uninjured for an indefinite period of time when once submerged, the perishability of the protecting sheathing would be matter of small importance. But although it is said that no disturbing influence exists at the deep sea bed, yet experience has more than once shown that no cable can be relied upon to remain sound at great depths, even when submerged in an apparently perfect condition.

Whether this liability to injury is owing to the chafing of the cable against rocks whose existence is unsuspected in mid ocean, the attrition of the cable against the rocks being occasioned by currents, or to imperfection in manufacture, remains to be shown. That rocks may exist at the bottom of the Atlantic bed seems possible, when we consider the strange freaks which Nature sometimes exhibits in placing huge boulders in the middle of an open prairie, without anything to account for their being there. If such rocks exist, it is easy to see that an iron-sheathed cable may bear a good deal of chafing without injury, under which a hemp-covered cable would fail. It is, however, quite possible that the faults which have developed themselves after a time

in the different ocean cables have been due to imperfection in manufacture. Not traceable when the cable was lying in the factory, these may have been discovered only when the cable was submerged and subject to the enormous pressure of water above it for some time. Such imperfections might be found out by the exercise of greater care in testing, and by a greater refinement in the present system, which in principle, however, seems to be all that could be desired.

As regards the mechanical strength of an iron, compared with a hemp-covered cable, the balance is wholly in favour of the former, for iron possesses some 25 times the tenacity of hemp; and even taking into account the loss of strength due to the weight of the wire in deep water, an iron wire $2\frac{1}{2}$ miles long or thereabouts, when immersed perpendicularly in the ocean, would still bear 16 or 17 times as great a strain as a rope of hemp would of an equal diameter. But there are causes which render an iron-sheathed cable more liable to fracture than a hemp one when being laid. One of these is due to the momentum which an iron-sheathed cable acquires when running out of the ship. This momentum is very great, in consequence of the weight of the cable; and any sudden check which might arise, either from some hitch in the paying-out machinery, or from a sudden lift in the stern of the ship, would throw a very severe strain upon the cable. With a light cable, this extra strain would be quite inconsiderable, as the momentum which it could acquire would be but small, and it might be jerked suddenly with but little danger of fracture. It is evident, however, that when a continuous pull is exerted on the cable through its becoming fast jammed in the machinery, whilst the ship is running, the iron sheathing would have the advantage.

One of the great disadvantages of iron sheathing is the liability of broken ends of wire to become forced into the core of the cable. This has been a frequent source of trouble in cable laying. From this disadvantage the hemp-sheathed cable is manifestly free. The liability to kink and foul is also greatly diminished by using a hemp cable. Inasmuch also as a light cable can be stowed away in ordinary sized ships, whose way can be easily checked, when an accidental hitch occurs in the paying-out machinery, another advantage is found by their adoption.

The electrical considerations put forward by the Light Cable Company do not in any way affect the question under consideration, except, perhaps, in so far as the improved instruments allow a comparatively small core to be used without any diminution in the speed of working. This consideration, however, is obviously as applicable to heavy cables as to light.

In conclusion, we may state that the relative values of the two types of cable can only be satisfactorily ascertained when the result of a light cable expedition is known. Should the result prove propitious, a great impulse will be given to submarine telegraphy, in consequence of the small cost of the new type as compared with the old. It is, however, doubtful whether, even should such an enterprise prove successful, the system could be adopted in tropical regions, where the destructiveness of marine insects is so great, and where various causes of mechanical injury exist in greater number than in higher latitudes.

THE WORKING OF THE "URGENT" TELEGRAM SYSTEM.

IN July, 1872, a regulation was passed in the Dutch Telegraphic Service with reference to "urgent" telegrams. The sender of a telegram to any office in Holland, or to certain foreign states, might require that the telegram be sent before others of the same rank. In that case he must write "urgent" on the telegram-form, and pay an extra sum, of course, for the privilege. Several details as to the working of this system have been furnished by M. Linckens to the *Journal Telegraphique*, and as they present some interesting features, we propose here to give a brief account of them.

Hitherto the right mentioned has only been exercised with regard to inland telegrams. From July, 1872, to the end of December, the number of urgent telegrams sent was 1892, commencing with 26 in July, and 78 in August, and reaching 563 in December. They were sent from 35 offices; and, with regard to their nature, the greater proportion, 1759, referred to commercial transactions and matters of the Bourse. In the first five months of 1873, the number of urgent telegrams was as follows:—January, 484; February, 568; March, 514; April, 403; May, 552. Comparing the entire number of inland telegrams during the eleven months, with the number of urgent telegrams, the proportion of the latter to the former is found to have been:—

In July, 1872	...	...	...	0.24	per 1000.
" Aug. "	...	...	...	0.71	" "
" Sept. "	...	...	...	3.28	" "
" Oct. "	...	...	...	3.24	" "
" Nov. "	...	...	...	4.91	" "
" Dec. "	...	...	...	5.73	" "
" Jan., 1873	...	...	...	5.14	" "
" Feb. "	...	...	...	6.16	" "
" Mar. "	...	...	...	5.70	" "
" April "	...	...	...	3.69	" "
" May "	...	...	...	4.66	" "

Of the 563 urgent telegrams sent in December, the Amsterdam and Rotterdam Offices sent, respectively, 333 and 194; total, 527, of which 503 were by the line between Amsterdam and Rotterdam. M. Linckens further divides them according to the hour at which they were presented by the public, and the result is as follows:—

Before 10 a.m.	...	...	...	12
From 10 to 11 a.m.	...	...	...	12
" 11 " 12 "	...	...	...	15
" 12 " 1 p.m.	...	...	...	21
" 1 " 2 "	...	...	...	53
" 2 " 3 "	...	...	...	81
" 3 " 4 "	...	...	...	285
" 4 " 5 "	...	...	...	56
" 5 " 6 "	...	...	...	4
" 6 " 7 "	...	...	...	6
" 7 " 8 "	...	...	...	4
After 8 p.m.	...	...	...	14

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The maximum per day was 36, and per hour 22, telegrams.

The large number between 3 and 4 p.m. is explained by the fact that it is then the Bourses of Amsterdam and Rotterdam are in full activity.

Even supposing (M. Linckens says) that all the urgent telegrams sent by Amsterdam and Rotterdam

had been exchanged between these offices, it is clear that on a line worked with three Hughes apparatuses and one Morse, the accelerated transmission of twenty-two urgent telegrams has been accomplished without prejudice to the facilities acquired for normal correspondence.

It might perhaps be urged that, although the system may work well at present, yet with the natural development of correspondence, the day cannot be distant when the service of ordinary telegrams between the places would no longer have the requisite certainty. To this it is replied, that apart from the consideration that the authorities would no doubt take measures to prevent the development of urgent telegrams becoming prejudicial to the ordinary service, these authorities would not, from a financial point of view, have any motive for delaying to increase the means of transmission so as to meet the requirements of the public. The charge for a simple urgent telegram being 2 fl., or a little more than triple that of an ordinary telegram, the average product has been raised to 1.1136 fl., or about 0.79 fl. above the average product of ordinary telegrams. Now in transmitting 500 urgent telegrams per month, or 6000 annually, the receipts of the inland service will be found augmented, through the new class of telegrams, 4764 fl., which represents a sum higher than the interest of the capital that would be required for putting up a new line between Amsterdam and Rotterdam, as well as the working of this wire during at least eight hours in the day.

With regard to the objection that the institution of a privileged category of telegrams offends public sentiment, M. Linckens truly remarks that, to give the public the opportunity, in pressing circumstances, of accelerated transmission is by no means an illegal or unconstitutional act; for this measure is not made in favour of certain persons, but the opportunity is open to all citizens without distinction.

The financial result, it has been seen, inspires no fear for the future, and the measure may be regarded as a step towards the best utilisation of the telegraphic system. In reference to this point, M. Linckens offers the following remarks:—

"As a general rule, tariffs should be constructed according to the importance of the services rendered. Thus, in the first place, the charges should be rigorously proportional to the distances; but as several causes lead to the extinction of the distances as an element of variation of the charges, the only logical and useful basis of a tariff is *promptitude of transmission*. To me it is evident that, by the adoption of a differential tariff based on the rapidity of transmission, the existing means will be better utilised. For in the search after measures which will lead to a maximum occupation of the lines, it is well to follow the advice given by commercial economic science, which, applied to the telegraphic service, is as follows:—In the limits of organisation of the system, it is more profitable to send telegrams cheaply than not to send them at all. Opinion may differ as to the mode of application of this principle, but it is the only one that is (industrially speaking) applicable. It hardly requires proof that telegraphy will better fulfil its end if it offer a promptitude somewhat proportional to the importance of the correspondence. This consideration leads, first of all, to sending, in the first place, the most pressing telegrams; and next, to a distinguishing in the series of the others

of those correspondences which do not strictly require a prompt transmission, so that they may be temporarily delayed. The rapidity of transmission should be satisfactory in all cases; and besides the senders being enabled to judge of the celerity they require for their correspondence might choose the mode of sending which suited them. The correspondences might with advantage be classified in the following three categories:—

- (1.) Telegrams for accelerated transmissions (to be first dispatched).
- (2.) Telegrams for normal transmission.
- (3.) Telegrams for retarded transmission (to be sent after exhaustion of those of the second class)."

ON THE ACTION OF ELECTROPHORUS MACHINES AND DOUBLE INDUCTION.

As in ordinary life the surprise over a new phenomenon often tends to attribute it to something strange and unearthly, so the early consideration of the Holtz electrophorus machines led to the notion that their action was of some mysterious nature, quite different from anything known in the domain of electricity. This idea has, however, been more or less dissipated. An interesting paper on the subject has been recently communicated to the Berlin Academy by M. Riess, in which, with the view of simplification, he builds up a Holtz machine from the principle of an ordinary electrophorus. A short account of his exposition may not be unacceptable to our readers.

Suppose a sheet of paper, $-K$, fixed on a glass plate of equal size, situated in a vertical plane. Place parallel to it, and near the paper, an equal-sized metallic plate at the end of a glass rod which can be turned about a horizontal axis passing through its middle. When the metallic plate stands opposite the paper, it is touched by a fixed insulated metallic rod A (the electrode). Then let negative electricity be communicated to the paper, and we have here a simple electrophorus, whose "cover," the rotating metallic plate, receives an amount of positive electricity, $+a$, while the metallic rod in contact with it receives a negative quantity, $-a$. The latter can at once be utilised. To utilise the positive electricity, let there be another metallic rod (the electrode) B parallel to the first, and in the same horizontal plane. Then, by rotating the glass rod, bring the "cover" to contact with B. As this takes a certain time, in which the electricity of the cover loses (through dispersion) a portion, n , B receives only the quantity $(1-n)a=ra$, where $r<1$. Of the two quantities of electricity excited by the electrophorus, there will thus be, for disposal, at the electrode A the quantity $-a$, and at the electrode B the smaller quantity $+ra$.

Greater quantities will be obtained if, opposite the electrode B, there be another vertical sheet of paper $+K$, fixed like the first, and positively electrified. The "cake" $+K$ then gives to the cover the quantity $-b$, and to the electrode B the disposable quantity $+b$. By rotating the cover, the quantity $-rb$ will be brought to the electrode A. After a complete revolution of the cover about its axis, we have, for disposal at A the quantity

$-(a+rb)$, and at B the quantity $+(b+ra)$. Both these quantities will be doubled if, instead of having only one cover at one end of the glass rod, another be added at the other end. Thus we have a *rotatory double electrophorus*.

After each turning, then, we have for disposal at A the negative quantity $-2(a+rb)$, and at B the positive quantity $+2(b+ra)$. The difference of quantities of electricity after each revolution of the glass rod is $2(b-a)(1-r)$, where r depends on the condition of the air. This difference disappears if either $b=a$, both electrodes acting exactly alike, or $r=1$, each of the covers retaining all its electricity while moving from one electrode to the other.

Such a construction of a double electrophorus out of the simple electrophorus would be inconvenient, inasmuch as both paper cakes must sooner or later be electrified anew. This can be remedied by means of the following principle:—A point fixed to an induced conductor on the side turned towards the inducing body charges the conductor with the same electricity as that of the inducing body.

Let glass discs, somewhat larger than the covers of the double electrophorus, be fixed to both of these, on the surfaces next the paper cakes. To the under edge of one, and the upper edge of the other paper cake, fix a pointed piece of pasteboard, and turn the glass rod so that each cover, before giving up its electricity to an electrode, passes a pasteboard point. The cover of A, which is $+$ electrified, will furnish the cake $+K$ with positive electricity, and the cover of B will furnish the cake $-K$ with negative, so long as the cakes can receive electricity. We have thus got a double electrophorus whose cakes are continuously electrified during its use. To obtain the best effects, however, there should be, instead of two covers, a large number of similar ones fixed to glass rods radiating from the axis.

A metallic comb in the neighbourhood of a body charged with electricity (as in the electric machine) permits the opposite electricity to stream out from its points. This may enable us to dispense with the large number of covers in the double electrophorus. Give to each of the two covers the form of a horizontal metallic comb, and fix them, with the points of the comb directed to the paper cakes, to the two electrodes. Between the combs and the cakes set up a glass disc, and rotate it instead of the glass rod. Each metallic comb allows the same kind of electricity as formerly the plate-cover received in its position to stream out to the glass disc, the two halves of which, accordingly, become covered, during rotation, with opposite electricities, which are carried by the disc to the electrodes, as they were, previously, by the moved plate-covers. As a small part of an electrified glass disc can be discharged while the remaining portions retain their electricity, the disc (supposing it well insulated) replaces the radiating system of covers, and furnishes the largest quantity of electricity. If the machine is set going when the paper cakes are very weakly electric, the electrodes must not be electric, otherwise the induction of the metallic combs would cease. The electrodes should therefore, at the beginning, be connected with the earth, or (which has the same result, and is generally more convenient) metallically connected with each other.

The machine thus gradually constructed (M. Riess proceeds to say) contains the theoretically essential parts of the Holtz electrophorus machines, and instructs us, therefore, as to the empirical action of these. That a *good* Holtz machine can thus be made is not asserted, though the apparatus is not altogether useless. M. Riess made one of moderate dimensions (which he gives), and he could, with it, charge a large battery pretty strongly. But the sparks between the electrodes were at the most $\frac{1}{2}$ in. long, and the machine "went out" soon when the disc stopped, or changed its poles if it was again set in action. To obtain longer sparks and a more durable charge, each paper cake should have, at the edge opposite that bearing the pasteboard point, a process in the form of a glass sector (which was continued by Holtz nearly as far as the pasteboard point of the other cake), out of this arose the fixed glass disc with two apertures. This disc is practically important, but in theory it is unessential; and it has done much to retard true knowledge of the working of the machine.

Hitherto the attention has been confined to induction in metal and paper; the induction in the rotating glass disc has not been considered.

A *double induction* occurs when an electrified body acts on a conductor furnished with points which stand near one surface of a non-conducting plate. This surface, suppose it an *upper* one, is then, by outflow of electricity from the points, made electric, and it acts inductively on the under surface of the plate, so that this has an electric layer of the same sign as the upper surface; and, immediately above, in the interior of the plate, a layer of opposite sign. This kind of induction M. Riess calls *self induction* of a non-conducting plate.

In all electrophorus machines with metallic combs, there necessarily occurs this double induction. Suppose a negatively electrified plate brought near a paper cake of a simple Holtz machine. The electrode opposite the cake becomes, through induction of the plate, negative, and the metallic comb fixed to it lets positive electricity stream out to the back surface of the rotating disc. This + electrified surface acts inductively on the anterior (front) surface; so that it receives negative and positive electricity, the latter at the part furthest from the back surface. By rotation of the disc, the electrified part comes near the pasteboard point of the second cake. Of the double electric layer at the front surface of the glass, only the + electricity can act on the pasteboard point, because the action of the - electricity is prevented by the + electricity of the back surface. The + electricity of the double layer makes the paper cake positive through induction, the pasteboard point letting - electricity flow to the front surface of the disc, thus neutralising a part of the + electricity of the double layer. On further rotation, the part of the glass disc in question comes to the metallic comb of the second electrode, which sucks off the positive electricity of the back surface; thereupon the double layer of the front surface disappears as far as the portion of - electricity, which, through neutralisation of + electricity by the pasteboard point, remains over. The metallic comb of the electrode becomes positive through the electricity sucked in; and further, through induction of the now positive cake, the metallic comb lets - electricity stream to the back surface of the glass disc, and thus excites in the front surface a

new double layer of + and - electricities, but with an excess of - electricity, as this has remained from the double layer that disappeared. When, now, the piece of the glass disc is turned round to the pasteboard point of the first cake, this takes up the excess of - electricity of the front surface, thereby makes the first cake negative, and the metallic comb sucks off the - electricity of the back surface. The electrode connected with the comb becomes negative, and the double layer of the front surface entirely disappears; whereupon the process is repeated. The excess of - electricity at the front surface of the disc decreases quickly with increasing charge of the two paper cakes, because the cakes cannot take more than a determinate charge. Then the double layer of the disc no longer acts inductively on the two paper cakes, but only through free pieces of pasteboard, each of which at its point gives one electricity, and at its base the other kind, in nearly equal quantity, to the rotating disc; so that the electricities at the front surface of the disc are not greatly changed.

For use in practice, the action may be briefly stated thus:—In consequence of double induction each electrode, in electrophorus machines, receives electricity of the same sign with that of the opposite cake, while the intermediate glass disc receives, on both its surfaces, electricity of the opposite sign.

MATHEMATICS

FOR

NATURAL SCIENCE STUDENTS.

By T. C. SIMMONS, B.A. Magdalene College, Cambridge.

(Continued from page 116.)

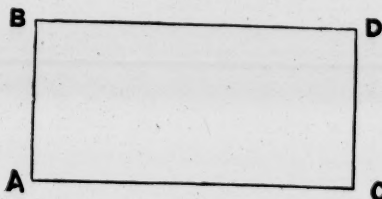
TRIGONOMETRY.

TRIGONOMETRY is the science which investigates those properties of a triangle which depend on the measurement of its sides or angles. The name is, in fact, derived from two Greek words, "trigonon," a triangle, and "metreo," I measure. It gives us rules for calculating the remaining sides and angles of a triangle, after some of them are known by actual measurement. It also enables us to find other magnitudes besides those directly connected with triangles: thus by its results we are able to find the area of a circle when its radius is given. The main object of the science, however, is to deal with those properties of a triangle which depend on measurement.

I need not, I think, explain that the word *area* means extent of surface. Thus we say when a field contains 4 acres that its *area* is 4 acres.

Suppose, now, a farmer has a field in the form of a rectangle, or such that all its corners are right

FIG. 1.



angles, while all its boundaries are straight lines, as the figure. If he wishes to know the area of the field, he can find it by measuring the lengths of its sides. Thus, suppose he finds the length of the

field, or AC , to be 100 yards, and the breadth, or AB , 50 yards, he multiplies 100 by 50, and so obtains 5000 square yards as the area, which can be expressed in acres, roods, &c., 1 acre being known to contain 4840 square yards. If all fields were rectangles, and it always was possible to measure their lengths and breadths, there would be no difficulty in finding their areas. But suppose there is a field in this shape—how is the farmer to find its

FIG. 2.

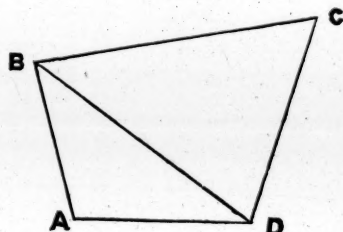


area? He wants to know it, because of course the rent will depend upon it, and also the expectation he forms of the produce which will be obtained from it.

Now trigonometry supplies rules for finding the area, after certain measurements have been performed.

Suppose the field divided into two triangles, by joining opposite corners, thus:—

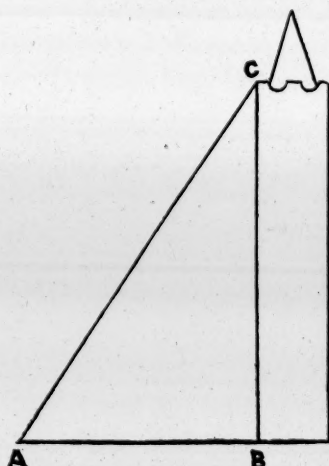
FIG. 3.



Then we can measure the lengths of AB , BC , CD , DA , and also that of BD by walking straight across from corner to corner: from these measurements we can find the area of each of the triangles ABD , BCD , and then add them together for the area of the whole field. Thus we see how useful trigonometry is.

Again, suppose we want to find the height of an object—say a church-tower. We might go to the

FIG. 4.



summit and let a line fall to the surface of the ground, and so by direct measurement obtain its

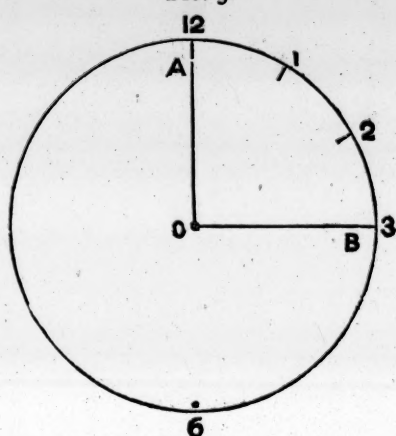
height. We might find it difficult to do this, however, and in fact we often wish to know the height of an object when it is impossible to ascend to its summit, and so measure it—the case of a church-spire, for instance. It is useful, then, to have another method of measurement, and this method is supplied by trigonometry. Thus, if a length, BA , be measured along the ground from the base of the tower, and the angle BAC be observed by a sextant, we shall be able to find the height, BC , without the trouble of ascending.

I will now explain how angles are measured:—Everyone, I think, knows what is meant by a right angle. It is the angle which the two hands of a clock make with one another at 9 o'clock, or at 3 o'clock. Now this well-known angular magnitude, a right angle, might be taken as the unit for measuring any other angle: we might describe an angle as being one-half, or one-third, or three-twentieths, of a right angle. This would be inconvenient, as there are so often angles in our investigations which, expressed in terms of a right angle, would involve very complicated expressions. Everyone can see how advantageous it is to divide a pound into shillings and pence; how inconvenient it would be if, instead of saying that the cost of an article was seven pence, we had to say that it was seven two hundred and fortieths, or $\frac{7}{40}$, of a pound. Exactly, then, as there is convenience in the subdivision of money, so is there in the subdivision of an angle. A right angle, consequently, is divided into 90 equal parts, each of them being called 1 degree. Again, it is convenient to divide these degrees, just as it was convenient to divide a shilling into pence. A degree therefore is divided into 60 equal parts, each of them being called a minute; again, a minute is divided into sixty equal parts, each of them being called a second. Again, it is convenient to have a mode of expressing the value of an article more briefly than by a number of words: instead of writing, for instance, that its value is three pounds four shillings and two pence, we put it thus:—£3 4s. 2d. A similar notation is used for expressing the size of an angle. The mark $^{\circ}$ denotes degrees, $'$ denotes minutes, and $''$ denotes seconds. Thus $33^{\circ} 51' 22''$ stands for 33 degrees 51 minutes 22 seconds. If an angle cannot be exactly expressed, even when we include seconds in our units of measurement, the remaining part is expressed as a decimal part of a second. Any further subdivision would bring in angles so small that they would be of no practical use whatever. In money the same thing occurs; it might perhaps be convenient, in some rare cases, to have coins of smaller value than one farthing, but the subdivision would not be of much practical use.

There is an illustration supplied by the face of a clock, as to the size of a degree, which I shall make use of:—Let O be the centre of the face of the clock. Then at 12 the hour and minute hands coincide, and include no angle between them. But they begin to separate, and the angle between them gradually increases. Let us imagine when the hour hand arrives at 12 that it is stopped there, so that it cannot move any more, but remains in the position OA . Then at a quarter past 12 the angle between the two hands is a right angle. The most common way of expressing the position of the minute hand is, as everybody knows, performed by means of divisions of the circle on which the hours

are marked, called minutes, and when the minute hand has arrived at the hour mark 1 it is said to be in a position whose distance from the mark 12 is 5 minutes; when it has arrived at the hour mark 2,

FIG. 5.



its distance is said to be 10 minutes, and so on. If we wish to be still more exact, we can express intermediate positions in terms of a smaller subdivision called a second. Thus, when half-way between 12 and 3 it is $7\frac{1}{2}$ minutes from 12, or 7 minutes 30 seconds from 12.

Now let us imagine that the minute hand is of such a length that its end is always just over some point of the circle on which the hours are marked; in other words, imagine that the length of the hand is the radius of the circle. Imagine, moreover, that the right angle is divided into 90 equal parts called degrees, instead of 15 parts called minutes. Then 1 minute will be equivalent to 6 degrees. If each degree be divided into 60 equal parts called minutes (the word here having a meaning entirely different from minute of time), and each minute into 60 seconds, we shall have subdivided the right angle into portions so small that any further subdivision would be useless. In fact, the division into seconds is only useful for such delicate measurements as those required in astronomy. Now what are the angles which the minute hand makes with OA at different times? Evidently at 1 the angle is one-third of 90 degrees, or 30° . So at 2 the angle is 60° . In any other position we can take the number of minutes, marked by the clock face, and multiply by 6 for the number of degrees. Thus at 7 minutes past 12 the angle is 42° ; at $9\frac{1}{2}$ minutes it is 57° , or $55^\circ 30'$. It will be useful for the reader to be able to form a rough guess of the number of degrees in an angle when he sees it.

Thus an angle such as—



is a little greater than half a right angle, and contains about 50 degrees, at a rough guess. An angle such as—



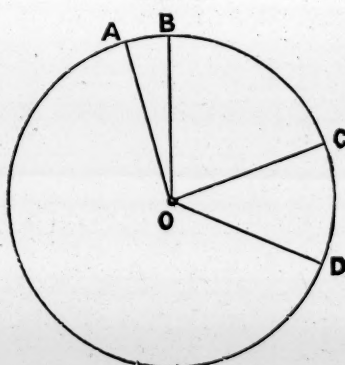
contains, however, only about 30 degrees.

I shall now explain a very important proposition which holds true with regard to the magnitudes of angles:—If a line revolve about one end, as the minute hand just considered, and a circle be drawn

with its centre at the fixed end of the line, and its radius equal in length to the line, then the movable end of the line will, in every position, always be on some point or other of the circle. Now measure along the circle, as in the case of the clock-face, a number of marks at equal distances; we may suppose, for the sake of clearness, that there are 90 of them in a right angle, and that each of them is called a degree. We can make ourselves sure that all the marks are equidistant by measuring the distances between them by a piece of string, or any other contrivance we may design for the purpose. Now take a pair of compasses, the legs being supposed to be just as long as the radius of the circle. Put its joint just over the centre of the circle. Open the compasses so that one of its legs is, say, at the point where degrees begin, or the point corresponding to 12 on a clock, and the other, say, just on the point where 15 degrees are marked. Now, without opening or closing the compasses, move them so that one leg is on the mark for 15 degrees, and the other on the mark for 30 degrees. It is found that this will be the case if we only move the compasses properly; we shall not have either to open or close them. What does this show? This—that equal distances along the circle correspond to equal angles (the degrees being supposed to be measured at equal distances along the circle). Therefore the angle corresponding to 30 degrees is equal to the sum of two angles, each of them corresponding to 15 degrees, or is twice the angle corresponding to 15 degrees. So the angle corresponding to 45 degrees is 3 times that corresponding to 15 degrees, and so on. Or we might take 1 degree instead of 15 as our first length. We should then find that the angle corresponding to 2 degrees is twice that corresponding to 1 degree, and so on: or, generally, the size of an angle is proportional to the distance marked along the circle between its bounding lines.

Thus, take a circle as the figure, O being the centre. Measure off a length, AB, along the circle,

FIG. 6.

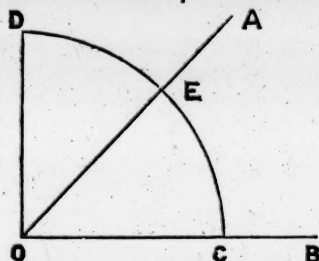


5 inches say: this may be done by means of a piece of string. Measure off another length, as CD; suppose it to be 19 inches. Then we infer this—that (the length AB being $\frac{1}{4}$ the length of CD), the angle between OA and OB, or the angle OAB, is $\frac{1}{4}$ of the angle between OC and OD, or the angle COD. We may vary the case by measuring different lengths if we like; the principle will always hold. Thus we see how angles are measured.

To measure, for instance, an angle which is given;

as $\angle AOB$, we may proceed thus:—Draw a circle with its centre at O , and any radius we like. Let OD be that radius which is at right angles to OC , and let E be the point where OA meets the circle. Measure the lengths of the curves CE and CD . Then the ratio of CE to CD is the ratio which the

FIG. 7.



angle $\angle AOB$ bears to a right angle. Suppose we have measured, for instance, CE to be 4½ inches, and CD to be 7 inches. The ratio is $\frac{4\frac{1}{2}}{7}$ or $\frac{9}{14}$. $\therefore \angle AOB$ is $\frac{9}{14}$ of a right angle, or $\frac{9}{14}$ of 90° or $57^\circ 14'$, or $57^\circ 51' 25''$; or, since $\frac{1}{9}$ of a degree is nearly equal to $51' 25''$, the angle is $57^\circ 51' 25''$ nearly. I need hardly say that the angle $\angle COE$ is the same as the angle $\angle AOB$, the magnitude of angles not depending in the least on the lengths of the lines containing them. The property just explained is often enunciated thus:—"Angles are proportional to the circumferences on which they stand." It is a very fundamental proposition in trigonometry. I might perhaps have taken it for granted, and said it is evident that it is so, without making any attempt to explain it; but I thought it better to enter into the matter at length, as it is so very necessary that it should be clearly understood.

ELECTRO-DEPOSITION OF METALS.

By J. T. SPRAGUE.

GRAVITATION acts upon matter according to its mere mass without relation to its nature; or, more truly, weight, our measure of the quantity of matter, is due to gravitation; but heat, electricity, and all the forces which act within matter rather than externally, have a selective power: they act differently on different forms of matter, and upon examination of this it is found that these forces act, not upon mere masses, but upon the atoms and molecules of which the masses are built up; their actions are related to the atomic weights and the valency of the several atoms. Thus a pound weight of iron would require twice as much heat to raise it to a certain temperature as a pound of silver would, but equal quantities of heat would raise to the same temperature an atom of iron 56 and an atom of silver 108.

But when electricity passes through solutions of these two metals, an entirely different condition arises. It would require just twice as much current (or twice the time with equal current) to deposit 56 of iron as it would 108 of silver: the reason is that the 1 atom of iron has two valencies, or stands chemically (in ferrous salts), in place of 2 atoms of hydrogen, while 1 atom of silver is equivalent to 1 of hydrogen. Thus it appears that heat is absorbed by matter in the ratio of its atomic weight, while electric current passes through matter in the ratio of its chemical valency.

But matter has another relation to energy in the form called chemical affinity: in this aspect each order of combination of each kind of atom possesses its own energy, which bears no known relation to any others: this specific energy is a matter for experiment in each case; but the energy given up in the act of combining (which may be measured either as heat or as electric action) bears an exact relation to what is called the affinity of the atoms forming that combination; to break it up we must apply a force equal to that affinity, and this fact means simply the law already mentioned, that in order to separate the atoms we must give back to them exactly the energy they parted with when uniting.

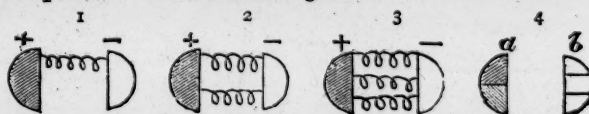
We may therefore conceive of substances as consisting of molecules built up of two parts, which are called *radicals* in chemistry and *ions* in Faraday's electrical nomenclature. There are many substances containing several radicals, but we are not concerned with them electrically, as only those substances which can form or break up into two radicals are electrolytes, or give passage to electric currents. These radicals may be similar atoms, as in metals, or they may be dissimilar atoms or radicals, as in salts: all that is to be attended to at present is the type or skeleton of matter as related to electricity, and the giving to this such a definite idea as shall enable the actions to be understood. These two constituent radicals are variously named, as—

+	—
Electro-positive	Electro-negative
Basylous	Chlorous
Cation	Anion
Basic	Acid.
	Such as—
Hydrogen	Chlorine
Metals	Sulphuric radical.

Various substances act as either radical, according to what they are united with, but in the electric current the radicals belonging to the first column turn towards the negative face or plate, and the second column towards the positive face or plate.

The two radicals are held together in a two-fold manner:—(1). By the valency of the radicals themselves: this constitutes the several classes of monobasic, bibasic acids, &c. (2). By the specific energy of the individual substance. Each of these bonds has a distinct electrical relation. The first governs what is called "quantity," and its actions; it constitutes what has been called the "equivalent of electricity." The second governs the tension needed to enable the current to pass when decomposition has to be effected, and is the basis of the old ideas of intensity. I think a purely mechanical representation will fix these ideas, but it must be remembered that this alone is its object, not to give a material conception of actual molecules.

Let us, then, typify the molecule as consisting of two parts held together by spiral springs; the number of the springs corresponding to the valency of the radicals, and the strength of the springs corresponding to the specific energy of the particular compound. We shall thus get:—

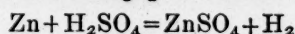


But either the one or other of these single

radicals may be replaced by separate atoms of single valency corresponding to one of Fig. 2 or 3, as shown in Fig. 4. Thus Type 1 represents the union of single monad atoms, such as metallic silver, Ag, Ag, hydrochloric acid, HCl, common salt, NaCl. Type 2 represents metallic copper, zinc, &c. and sulphates of those metals, CuSO_4 , ZnSO_4 . By regarding the + radical as composed of two distinct monads, as in 4 a, it represents the sulphate of sodium, Na_2SO_4 , sulphuric acid, H_2SO_4 , and corresponding substances; or by regarding the - radical as similarly divided, it includes the chlorides and nitrates of dyad metals, as zinc chloride, ZnCl_2 . The same applies to all the other classes.

The atomic weights are purely relative; they apply to proportions only, whether grains or tons; but if we give them a fixed meaning these molecular types give us the most perfect possible unit of electric quantity and current. Let us consider the weight as taken in grains; then taking hydrogen 1 grain and 1 valency as our base, we have the unit of quantity as that necessary to set free from combination 1 grain weight of hydrogen or 1 atom of any monad, or to do equivalent work in any other atom; thus iron 56 grains, or zinc 65.2, would require two units of quantity to set them free, or would furnish two units themselves while dissolving. To convert this into "current" time has to be taken into account, and for convenience of calculation I take ten hours. Then we measure electric currents by 1 grain of hydrogen, or equivalent action in ten hours. This unit I shall use and call a "Chemic." The British Association unit of current, the veber, is equal to 5.68 chemics, and thus all calculations in one unit can be readily converted into the other, remembering that this ratio is that not of "quantity" but of "current" for equal periods, as the veber is defined upon the time of one second to measure "quantity."

The various chemical facts and reactions are concisely expressed in symbols, which generally are the first letter of the name of the element in English or Latin: each such symbol stands for 1 atom of the element, multiplied when necessary by a small figure following it a little below the line: all reactions are expressed by first writing in symbols the construction of the substances set to act upon each other, divided by +, and then the substances produced, and the two should exactly represent the total atoms engaged. Thus—



shows that zinc acting upon sulphuric acid produces sulphate of zinc and free hydrogen, and, as we know the relative weights of all the atoms, such an equation shows at once how much of the materials we are to use, and what the product will be. These equations only represent the matter of the reactions; they tell nothing of the forces engaged.

Few people have yet studied these forces, and our information on them is by no means accurate as yet. Most of the experiments on which it is based have related to the heat given out by different substances when burning in oxygen or chlorine, or by chemical reactions, and as these experiments are extremely difficult the results can only be considered as approximate. Such knowledge as we have is contained in columns VII. and VIII. of the following table, which are the energy expressed in foot-pounds

A. RELATIONS OF ELEMENTS.

I.	II.	III.	IV.	V.	VI.	VII.	VIII.
Name.	Symbol.	Atomic Weight.	Old Equivalent.	Valency.	Electric Equivalent.	Foot-Pounds per Grain Equivalent.	
						Oxy-gen.	Chlor-ine.
Carbon	C	12.0	6.0	IV.	—	2946	as CO
Chlorine	Cl	35.5	35.5	I.	35.5	9624	as CO ₂
Chromium	Cr	53.5	26.7	Cr ₂ VI.	—	—	—
Copper	Cu	63.5	31.75	II.	31.75	3802	5862
Cupreous salts..	Cu ₂	127.0	—	II.	63.5	—	—
Gold, auric	Au	197.0	197.0	III.	65.7	—	—
Aurous salts	"	"	"	I.	197.0	—	—
Hydrogen	H	1.0	1.0	I.	1.0	6841	4721
Iron, ferrous	Fe	56.0	28.0	II.	28.0	6565	6492
" ferric	Fe ₂	112.0	56.0	VI.	—	—	—
Lead	Pb	207.0	103.5	II.	103.5	5494	8880
Manganese	Mn	55.0	27.5	Mn ₂ VI.	—	—	—
Mercury	Hg	200.0	100.0	II.	100.0	—	5.9 ³
Mercurous salts	Hg	"	"	I.	200.0	—	—
Nickel	Ni	59.0	29.5	II.	29.5	—	—
Nitrogen	N	14.0	14.0	III.	4.7	—	—
Oxygen	O	16.0	8.0	II.	8.0	—	—
Platinum	Pt	197.0	98.5	IV.	49.25	—	—
Platinous salts..	"	"	"	II.	98.5	—	—
Potassium	K	39.0	39.0	I.	39.0	15135	1999 ⁶
Silver	Ag	108.0	108.0	I.	108.0	1214	690 ⁸
Sodium	Na	23.0	23.0	I.	23.0	14593	1878 ⁵
Sulphur	S	32.0	16.0	II.—VI.	—	3526	—
Tin, stannous	Sn	118.0	59.0	II.	59.0	6654	6297
Stannic salts	"	"	"	IV.	118.0	—	—
Zinc	Zn	65.2	32.6	II.	32.6	8427	9985

given out by the combustion of the more common metals, &c., in oxygen and chlorine. Column I. is the names of those elements likely to be of consequence in electricity; II. is the symbol of each element; III. the atomic weight according to the "new notation" now generally adopted; IV. the old chemical equivalent, which is also the weight taken in grains, to which columns VII. and VIII. refer; V. is the valency, according to the views already explained above, and as related to electricity; VI. shows the weight corresponding to 1 unit of electrical current, the chemic, varying in some instances where two classes of salts are formed; VII. is the energy of union with oxygen; and VIII. that with chlorine of the weight in grains of column IV.

The teachings of this table will be explained in the next paper.

CAN ELECTRICITY BE PROFITABLY EMPLOYED AS A MOTIVE POWER?

THERE was recently on exhibition in one of our industrial expositions a series of pumps, worked by exhaust steam, over which was placed the startling announcement that, by means of them, water might be raised to a given height, in quantity sufficient to drive a water wheel which would give out more power than the steam engine itself! The placard was well calculated to attract attention, but then nobody believed the statement printed on it, for the simple reason that no engine, far less the exhaust steam from one, could ever pump up water enough to drive a wheel which would give out half the amount of power of the original motor. The waste in pumping and the loss caused by want of efficiency in the water wheel would be sure to consume the other half. Now, it happens curiously enough, that there are in common use two methods for producing dynamic electricity—one being the voltaic battery and the other any form of mechanical power. In regard to the latter, it is evident that the same principle holds true in regard to it that is true when

applied to the water wheel and steam engine above mentioned. If electricity, which has been produced by the agency of mechanical power, be applied to the driving of an electro-motor, the latter can never be made to give out as much power as has been exerted by the engine employed to produce that electricity. In other words, no one could be found so foolish as to employ a steam engine to produce electricity for the purpose of operating an electro-motor intended to drive machinery. It would evidently be vastly more economical to drive the machinery by means of the engine itself, without the intervention of any complicated apparatus.

This proposition is so self-evident that it requires no elaborate demonstration; but from it follows the very obvious conclusion that, if by means of the steam engine we can produce electricity more cheaply than we can by the voltaic battery, then it is evident that the battery cannot compete with the engine as a source of power, no matter how perfect may be the electro-motor through which the energy derived from the battery is applied. Hitherto it has been claimed that the only difficulty in the way of applying electricity as a motive power, consists in the absence of a properly constructed electro-motor; but if it can be proved that electricity can be produced more cheaply by means of steam than by the consumption of zinc, then it is clear that even a perfect motor—that is to say, one that utilises all the electrical energy, and converts it into mechanical power—cannot enable the battery to compete with steam.

Here, then, is a crucial test which is easily applied. And we believe that the results already attained do not leave the question in any doubt. In the case of the electro-deposition of metals, as well as the production of the electric light—two instances in which the comparison between the engine and the battery may be made with great accuracy—it has been found that the engine is the most economical. *A fortiori*, it should be far more economical as a source of mechanical power.—*Industrial Monthly*.

Proceedings of Societies.

SOCIETY OF TELEGRAPH ENGINEERS.

At the meeting of this Society on Wednesday, the 25th of February, Mr. NATHANIEL J. HOLMES read a concluding paper on "On Electrical Torpedo Defences," with especial reference to operations on land, the naval aspect of the subject having been dealt with in the former contribution.

The paper stated that the carrying out of an electrical system of torpedo mines for land defences against the attack or approach of an enemy is a task of much greater difficulty than the protection of a coast by similar means by sea. It is not possible to mine and dig trenches in the face of an advancing foe. Traces of such operations are sure to be discovered by the enemy, who could then easily destroy the defence by cutting the wires, could any clue be obtained to their position. The Russians appear to have devised some kind of electrical mines for the defence of the Malakoff tower during the Crimean war in 1854, as in digging the trenches for the assault of that position, insulated wires were found and cut by the English officers. And it is well known that Professor Jacobi at that time introduced the use of mechanical torpedoes as a part of the Russian defence in the Baltic Sea against the approach of the English fleet. Fortunately, these torpedoes proved to be utterly powerless to destroy any of the vessels which came into collision with them; and in the case of the mines at the Malakoff no effective results followed. In the American

war in 1864, mines were laid down for the defence of the approaches to Richmond, but never sprung. And in 1871, while Paris was in the hands of the Commune, electrical mines were in part carried out in some of the subways, but they were removed by the government before any destructive effects were experienced. With the exception of these inoperative examples, there exists no precedent to guide the military engineer in the construction of his defence. With sea mines in naval warfare it is possible in 24 hours to establish a defence. With military torpedo defences, this is not possible, every position occupied and point of attack laid down requires to be covered either by artillery or adjacent mines, and therefore to form a part of a concerted system. Thus any efficient electrical land defence should, if possible, be established before an enemy is in the field, each successive line and system of "advance" mines trenched out, and the insulated conductors brought into their respective centres of operation, the several stations for concurrent angular observation established, and the mines placed in readiness for effective discharge, so that at any moment, in case of war, they might be called into action. When, therefore, an electric system is to be employed in military tactics as an auxiliary to that of the defence by heavy ordnance, the position of the circuits and the area of destruction of the mines must of necessity be concealed from the enemy; and the successful carrying out of these defences by a secret service department will in a great measure frustrate the designs of spies and informers giving information to the enemy of the position of the mines and wires. Originally it was intended that the chief approaches to Paris, in the war of 1871, should have been covered by means of a series of subterranean electric mines: and a very efficient system had been prepared, and would have been carried out, by which all approaches into the city would have been effectually closed except at a vast destruction of life. Time would not have admitted of any such special system of defence as the writer of this paper would suggest should be carried into effect for every system of permanent defence where electric mines are to be employed as an auxiliary to the range of artillery; but still sufficient time remained to have made every approach around Paris impregnable to the advance of the Prussian army by the placing of mines without the lines of fortifications under cover of the guns of the several forts, and other mines within the line of fortifications, controlled by observing-stations from the top of some of the more prominent public buildings. By this means, a treble line of effective defence would have been established: 1st. That at a distance beyond the range of projectiles from the forts, and which would have operated against the establishment of the Prussian batteries upon the heights surrounding Paris, and the firing from which caused so much destruction to private property; 2nd. The defence afforded by the artillery of the several forts; 3rd. That of the secret service fougade within the lines of fortification, closing the approaches into Paris. One or two well-directed "shots" would have terminated the march of the most enthusiastic general, ignorant as he would be of the nature of this internal defence. It is fearful to contemplate the amount of death and destruction that would have taken place had these mines been laid and sprung. Grape shot, segment-shell, and the milletrailleuse in their destructive effects could not be compared for a moment with the fearful *aceldama* they would have caused. These land mines, concealed beneath the surface of the ground, and constructed in the form of a shallow inverted cone, into the apex of which the bursting charge is placed, calculated to "throw" the superincumbent mass,—composed of some hundred tons of broken granite and paving-stones,—would be about as deadly a fougade as could well be conceived; on its

explosion death is sown broadcast, and the successive explosion of two or three such "detonators" would almost annihilate the advancing columns of an army. As it was, the indecision of the French Governmental heads of departments deferred the consideration of this all-important system of defence until it was too late to be made available. The Prussian army fast advancing upon Paris, and gaining position after position, frustrated any organised system of long range defence, while at the same time the Government of Great Britain having declared that telegraph stores and coals were contraband of war effectually prevented the proposed defensive measures being carried into effect. The value of electrical mines for military defence is greatly enhanced when the same are laid down as a permanent system auxiliary to that of forts and earth-works for the maintenance of any special fortified position, because it is then quite easy to extend the wires without detection to distances covering the approach beyond the range of guns. Properly trenched into the earth at depths not less than from 8 to 10 feet, the wires would be as secure from injury as most submarine cables lying in deep water. The chambers to contain the charge should likewise be constructed in a permanent manner. At a comparatively small expenditure, masonry might be employed in the construction of water-tight compartments, wherein the charge could be deposited for any period without detriment to its explosive properties. If a charge can be submerged for thirteen months under water, as was the case with the James River mine, a military defence properly laid could be maintained for an indefinite period underground. In military defences by means of the electric agency, the employment of mechanical contact-breakers and circuit-closers is inadmissible. Circumstances might possibly arise in submarine defences which would admit of such arrangements being introduced; but in military torpedo works they are absolutely inadmissible. Mechanical action of all kinds, however simple, is unreliable, because however perfect the apparatus may be in its construction when first placed in position, variations of temperature, rust, corrosion, sea-water growths, friction, and the many uncertainties incident to all mechanical appliances left to themselves for any length of time, destroy all reliance upon their accuracy of performance. Now, in warfare mechanical torpedoes once placed are left to themselves; to inspect them, or overhaul the working of their parts, is fatal in two ways,—possibly to the forlorn hope sent to carry out the inspection, and secondly, because any such inspection might give the enemy, always on the alert, intimation of their existence and a knowledge of their position. Reliance, therefore, upon any such mechanical apparatus may prove most disastrous to the defence. When most required, as in the case of the Richmond fuse mine, they are in nine cases out of ten inoperative. Again, mechanical appliances depend for effective explosion not only upon the perfection of their mechanism, but upon percussion, from actual contact with the enemy. This limits the field of action, as, unless the enemy actually strikes the mine, no explosion can take place, but as the effective area of destruction of a properly constructed mine is equivalent to that of a circle the diameter of which is 90 feet, with the electrical system a ship may be fatally injured, even though not immediately over the mine, so long as she is within the area of its destructive effects. It is an interesting incident in the defence of Venice against the attack of the French, in 1859, when the Austrians, under Ebner, fortified the sea approaches to Venice by means of electric torpedoes, to recur to the very ingenious method they adopted to ensure the explosion of the mine only when the enemy was within the area of that special defence. By the employment of the camera obscura, the positions of the various mines as

laid down by the engineer were marked on the obscura chart, and the area of their destructive effects indicated on the map by a circle, so that the approach of any of the enemy's ships into the bay of Venice would have been observed by reference to the obscura chart, and as soon as they passed within any of these destructive areas, electric currents were so arranged as to explode the mine and discomfit the advancing foe. The armistice that followed prevented the completion and testing of these proposed defences under the ingenious system at that time devised by Baron Ebner, and the few that the Austrian Government actually laid down were removed without having been called into action. This defence, however, marks an epoch in the advance of torpedo engineering. Of the mechanical torpedoes devised by Jacobi for use in the Baltic, in 1854, the few that exploded proved the arrangement to be only a mechanical toy. It is only within the last few weeks that a fatal accident occurred in the Government laboratory, at Woolwich, with the mechanical self-propelling fish torpedo. How far this machine may be available in actual warfare may well be a matter for grave consideration. The value of the simple electrical system of defence by land and sea is at present more or less neglected; but, built up to form an integral part of our water defences and land fortifications, how valuable would the system prove should the stern realities of warfare actually arise. The employment of the electrical agency for exploding mines is safe, simple, inexpensive, and absolutely certain, while mechanical appliances are uncertain, costly, and dangerous. The object of the author in this and the previous paper has been, not so much to advocate any special system of manipulation, or to discuss the practical details of apparatus, as to point out that the true value of the electric torpedo defence consists in the employment of the direct action of the current as alone affording that security without which no torpedo system can be trustworthy. Of the importance now attached to the electric torpedo system of defence, the torpedo armaments of Russia, Sweden, Norway, and the United States of America testify. It is a matter for reflection to learn that while, in 1865, the governments of France, Holland, Belgium, Denmark, Norway, Sweden, and Russia paid special attention to this subject, and recognised the value of the defence, at that time the Government of England remained apathetic, and it is a question how far our hybrid system of mechanical ignitors and circuit-closers, and compressed air-propelling machines can in action compare with the splendid organisation of electric torpedoes that now form an integral part of the naval and military defences of Russia, the United States, and Sweden.

The CHAIRMAN (Mr. Latimer Clark) said, that as they were all electrical people, they would all readily agree with Mr. Holmes in admiring electrical means of ignition. He believed that Mr. Holmes had some peculiar form of torpedo which he wished to recommend. If that was so, it would be very gratifying if he would describe generally the system he wished to recommend.

Mr. HOLMES said that he was not prepared to advocate any particular system. What the chairman had stated was correct, for at the time of the American war a special system was devised by the late Lieutenant Maury and himself (Mr. Holmes) with a view to give greater security and efficiency in the discharge of electrical defences. That system was well known, and had been investigated by four of the governments of Europe. The experiments which had been carried on by our own Government had most probably elucidated new facts, but, whatever facts were known, one of the great values of a torpedo defence was secrecy, and he did not propose to enter into any details on the subject.

MAJOR MALCOLM said that Mr. Holmes had evidently taken a great deal of trouble to get information from other governments, but he had talked as if we had done nothing. He (Major Malcolm) was not prepared to see on the table instruments which had been elaborated under his own supervision, and the supervision of his predecessor, with the assistance of some gentlemen who were then in the room. The War Office and the Admiralty flattered themselves that those instruments were profound secrets. He might say for the information of those who did not know him personally, that he was connected with a school down at Chatham, called the School of Submarine Mining; and they had gone as closely as time and various opportunities admitted into the subject of electrical firing, mechanical firing being almost entirely put on one side, except for special purposes, on account of what they believed to be the most insuperable difficulties of putting mechanical torpedoes down, and, worse still, of taking them up after the necessity for them had ceased. He had taken the liberty of making a few scratches on Mr. Holmes's first paper. He really did not exactly know what to say. The Government often got attacked as Mr. Holmes had attacked them; and when they came to examine the paper, they found such a terrible quantity of what seems to them to be vague statements. On the second page of the paper he read:—"As mechanical appliances can be obtained at less cost than the maintenance of a standing reserve, the defence of a kingdom resolves itself, in great part, into the establishment of properly applied scientific systems, controlled by intelligent operators, as against the too often lavish expenditure of revenue in the construction of unwieldy armaments of guns and armour-plated ships competing for mastery," and so on. Well, now, torpedoes were all very well in their way; but an island like ours, with colonies and so on, must have ships and massive guns. We might put down as many torpedoes as we liked, but they were wanted to stop where we put them down, because if they did not the camera obscuras or anything else would be of very little use. Almost in the next line he found, "with the electric torpedo this competition ceases. At the cost of a few thousand pounds, the strongest ship, with its heavy guns and gallant crew, fitted out at a cost of hundreds of thousands of pounds, becomes comparatively inoperative for the attack." But if a torpedo was to cost a few thousand pounds, it would puzzle anybody to make it very simple, unless it was made of gold or platinum, or something of that kind. Then again, "half a dozen men in control of the torpedo mines can effectually keep at bay both an army and a fleet." Now, what could half a dozen men do? And when we came to go into the matter, we found that a great many half dozens of men were wanted; and yet it seemed, in reading a paper like this, that it was all exceedingly simple. He assured them that it was exceedingly difficult. Then the James River torpedo was quoted. This was an electric one, and it was said that the defence of the river was entrusted to a single electric mine. He spoke now without book, but it was his impression that there were a great many mines put down, and a great many mines taken up; and there happened to be one which was not taken up, and which went off at the right time, and did its work. If he had been rightly informed, there were a great many more ships than one destroyed in the American war, and a very large proportion of them was destroyed by mechanical mines. Nevertheless, our Government did not contemplate the use of mechanical mines in this country to any great extent, for they exposed the people who work them to a terrible loss of life. A case was quoted in the paper as to the Prussians. They were said to have lost a great number of their own men in that way. Then again, here was a curious vagueness. "To render any

system of electric torpedo defence practically useful and reliable, it must be under the perfect control of the officers and men using that system." But how were they going to make it so that any inexperienced officer was to work it when it was going to blow up. It could not be done. There were two or three little difficulties that occurred to him, and if any electrician would solve them, he should be delighted to take the hint. And one difficulty was this. It was stated "it is likewise necessary that the electrical arrangements shall ensure the ignition of the torpedoes by land and sea, at distances exceeding the effective range of cannon." That was, of course, very easy, if there was only enough battery power. "And that when necessary, more than one mine shall be exploded in group simultaneously on the same circuit." And then, again, there was to be the power of exploding mines even if the enemy should succeed in breaking the wires." He confessed that he was regularly flooded by that. The power of testing mines at all times had been most carefully thought out to the best of the abilities of a good many officers who were daily working at it; but it was not their opinion, as a rule, that it was at all desirable to talk through a mine. They could generally manage to communicate in some other way. Then there was a very interesting thing on record about M. Chabannes at Toulon. The experimenting party were knocked down on the jetty, and there was no sign on the surface of the water. He (Major Malcolm) wished that the writer of the paper had told them what the charge was, and what the depth was, and how far off it was; but papers that left out all those things were, for the purposes of those who were charged with the torpedo defences of the country, absolutely useless. As for the chemical fuses and the platinum wire fuses, it might be interesting to the meeting to know that the Government school had both sorts. He had read of the *New Ironside* which was for two hours grounded on a torpedo, and it was an electrical one, and would not go off. They nearly shot the officer in charge as a traitor. There must be some improvements upon what they did in those days, though they did very well; and the Prussians did very well considering. Professor Jacobi had not only a mechanical system, but an electrical system, but he had an exaggerated idea of the power of powder, or too mean an idea of the power of the ships. An officer who picked up a good many of the Russian torpedoes told him (Major Malcolm) that they contained from 10 to 15 lbs. of powder; and if any of them exploded at all, they went off like a squib, and did not hurt anyone. The system of military mining which the author proposed would be very difficult to carry out; but mines now-a-days would, undoubtedly, be fired by electricity as they were constantly fired at Chatham, and had been for the last 20 years. Sir Charles Pasley had a good deal to do with introducing that method. War was a question of money after all, and the general idea of sowing mines broadcast all along a road was a question of money, but how far were such mines to extend, and how were they to be kept secret? If an army was advancing, all the roads would be carefully examined, and he thought that it would be found that a good deal of money had been wasted, if such a general system of mining was carried out. If he had seemed warm on the subject, it must be remembered that official incapacity was very constantly alleged, as if the departments of the Government had nothing to do but to sit upon inventors, and make themselves generally obnoxious. He did not think they did so, but he really thought that they tried very hard to do their best. Of course they had not infinite knowledge; but who had? As to the unfortunate Whitehead fish torpedo that exploded the other day, it did not do anything more than hundreds of boilers did every year. He would deliberately say that he thought it a

very valuable invention. Austria was not a very wealthy country when it paid to Mr. Whitehead £18,000 or more for the secret of the fish torpedo. And a very short time ago anybody might have seen in the estimates the torpedo defences of this country put at something like £500,000, so that the Government had been alive to the advantage of submarine warfare; and the system of electrical ignition had been recognised and adopted long ago.

PROFESSOR ABEL said he might, as a matter of interest, refer to one or two points that Major Malcolm had spoken of, in connection with the application of electricity to the explosion of mines, both land and submarine. He had rightly said that Sir Charles Pasley was the first to apply electricity to the explosion of mines more than a quarter of a century ago in England. Some few years before, experiments in the same direction had been made in France. The latter were the first experiments that were made in connection with the explosion of mines by electricity; and Sir Charles Wheatstone and Professor Daniell, of King's College, were very naturally much interested in the application of electricity in this direction. Colonel Pasley was acquainted with those gentlemen, and it was in the laboratory of King's College, about a quarter of a century ago, that the first arrangements for the explosion of submarine charges were thought out. These were applied to the blowing up of the wreck of the *Royal George* at Spithead; and not long after that electricity was successfully employed for the explosion of land mines by the Royal Engineers, under Colonel Pasley's direction. In 1854 a most interesting and elaborate paper, in connection with the subject, was published by Colonel (then Captain) Ward in a very valuable publication not generally known—the professional memoirs of the Royal Engineers. In that paper he went very much into detail with regard to the batteries that should be employed, and with regard to the description of fuses and of conducting wires, which he had selected by careful calculations, verified by actual experiment. One result of his labours was, that an improved Grove battery was introduced into the Royal Engineers' service, and it was in use until lately. In 1856, Professor Wheatstone and he (Professor Abel) happened to be members of one of those very much abused Government Committees, and Professor Wheatstone proposed that the subject of the application of electricity of induction, and electricity of high tension from different sources, to the explosion of mines, should be carefully enquired into; and, in consequence, Professor Wheatstone and he carried on, for some years, both at Woolwich and Chatham, a series of experiments, which resulted in the development of the magneto-electric exploding machines of Wheatstone and others, and also in the production of improved high tension fuses. About the same time, or shortly before, Baron Von Ebner, in Austria, had applied frictional electricity successfully to the explosion of mines. As far back as the days of Franklin and Moses Shaw frictional electricity had been so used in a somewhat uncertain manner, but it was Baron Von Ebner who first worked out a practical system. Then a Spanish officer, and a French officer in conjunction with Ruhmkorff applied the induction coil to the same purpose; and so several persons, not only in Austria, but also in France and England, were working together at the subject, applying electricity from different sources to the explosion of mines. He did not believe that the subject had for a single month, during the last twenty years, been neglected in this country. There was no country that was really in advance of us in this respect. We received frequent visits from foreign officers with special credentials referring them to us for information as to the explosion of mines, both land and submarine. With reference to Mr. Holmes's paper, he (Professor Abel) presumed that the author objected not merely to purely mechanical

mines, but also to circuit closers, except in special instances. Now he (Professor Abel) could not conceive how any system of electric mines could be perfect which should be harmless at night, or, at any rate, in weather which was not sufficiently clear to allow of working by means of the telescope. It was possible to use the circuit closer alone as the exploding agency, but it was impossible in any perfect system of submarine defence to depend alone upon firing by observation, leaving out a circuit-closing or circuit-breaking system.

MR. VON TREUENFELD said that he wished to be allowed to draw the attention of Mr. Holmes to the fact that there had been another torpedo war of, perhaps, equal importance, and of longer duration than that in the United States in 1864. It was a war which, during four years, was operated with torpedoes. It lasted six years altogether, and torpedoes managed to keep back a navy of more than fifteen ironclads and fifty or sixty men-of-war during a period of four years. He alluded to the war between the republic of Paraguay on the one side, and the empire of Brazil, the republic of Argentina, and the republic of Uruguay, on the other side. The republic of Paraguay was blockaded during six years by the Brazilian fleet, consisting at times, as he said, of as many as sixty men-of-war and fifteen ironclads, and by the Brazilian army, and the army of the two other countries, which were composed sometimes of as many as 80,000 men. He was several times in charge of the torpedo department, in the republic of Paraguay. They used chiefly mechanical torpedoes, as they had no materials in the country for anything else, and they had to manufacture everything themselves; and by means of these mechanical torpedoes, this immense fleet, combined with an army of from 70,000 to 100,000 men, was for four years kept from making any rapid advance. He also tried to use electrical torpedoes, but in consequence of the blockade, he was unable to obtain proper materials. His assistant engineer, Hans Fischer, who died in the war, succeeded in manufacturing cables, but under great difficulties, as the soldiers had to go out to tap the india-rubber trees, and draw the milk. This made the supply deficient. He mentioned these facts, as he believed they had never been printed, and might be very little known amongst torpedo engineers. In the war to which he had referred, at least 300 torpedoes were laid down. Mechanical torpedoes were very useful when electrical materials were not at hand, and their existence was, perhaps, the reason why this war lasted for six years instead of being finished in one.

The CHAIRMAN asked what was the nature of the mechanical torpedoes which were used.

MR. VON TREUENFELD replied that the torpedoes were moored, and that they had chemical fuses in glasses which broke when struck. The electric torpedoes were ignited with platinum wire.

PROFESSOR ABEL asked whether there were any casualties in laying or removing the torpedoes.

MR. VON TREUENFELD said that he was the only survivor of those who were engaged with the torpedoes. Of the others, those who did not blow themselves up died in the war.

Lieutenant SCOTT said that he had not heard the paper, but he gathered from Professor Abel's remarks that the author preferred a mine without a circuit-closer. He would say, from experience, that it was absolutely impossible, unless moorings were laid down beforehand, to put a submarine mine in any given position; and if moorings were used, what became of the secrecy?

Lieutenant WATSON said that the author had stated that the destructive effect of a torpedo explosion extended over an area of 90 feet diameter, but he had omitted to state what the depth of the water was,

what the charge was, or what sized ship he was speaking of. It was known from experience that the area of the destructive effect was proportionate to the charge. He should like to know upon what Mr. Holmes founded his observation.

Mr. ARTHUR R. GRANVILLE asked whether earth-currents would affect torpedoes so as to prevent their being a permanent defence.

Mr. HOLMES said, with reference to Major Malcolm's observation on his statement that torpedoes would cost a few thousand pounds, that it must be remembered that the greatest expense was in the maintenance of proper electrical circuits. His paper contemplated a properly-laid and organised system of permanent defence. The same fact must be remembered in connection with his statement that a handful of men could defend the whole of Portsmouth Harbour. A properly laid down system could be maintained at a very small expense, and this expenditure would contrast favourably with the amount spent in the rivalry between heavy guns and thick ironclads. His statement with regard to the area of destruction being 90 feet was derived from Lieutenant Maury's observations in the American war, in which he (Mr. Holmes) and Lieutenant Maury worked together. He particularly stated in the paper that he could not go into any details as to the charge. Water being nearly incompressible, the effect of the explosion of the mine was to drive the column of water to the bottom of the ship. The column of water took the place of a shot, and he had expressly stated in his paper that the charge of powder had to be regulated by the depth of water and the area of destruction. He believed that in the experiments of Admiral Chabannes, at Toulon, the depth of the water was 60 fathoms, and the charge 30 lbs. He regretted that Europe had not had fuller information with regard to the use of torpedoes in the South American war. The results of the mechanical torpedoes there used had been most important; but still it must be borne in mind that the defence in that case was a river defence, and there were certain facilities connected with such a defence which did not exist in a harbour or in the open sea.

Professor ABEL asked how Mr. Holmes would defend a passage at night by torpedoes without any self-acting arrangements.

Mr. HOLMES said that Maury proposed to defend his torpedo mines against the attempt of the enemy to drag for them by covering the line of defence with guns, or by throwing an electric light or lime light where the enemy would have to pass, so as to show the position. In torpedo systems they were not supposed to work in the open sea, but in a harbour or channel. His objection to mechanical appliances held good with regard to circuit-closers. Such things might be relied upon exclusively, and might fail. Mechanical apparatus would never for two weeks together be reliable unless it was continually watched. They could not be continually going in boats to inspect it. No intimation should exist in the face of the enemy that anything was laid down.

Professor ABEL—But is it not better to have two strings to your bow, and also to have a chance of the torpedoes being effective during the night?

Mr. HOLMES said that he quite agreed with Professor Abel that it was quite right to have two strings to our bow; but to let the defence rest entirely on mechanical appliances he considered was not desirable.

Major MALCOLM said that he hoped that Mr. Holmes would not think that he wanted to snatch an easy victory in talking about thousands of pounds that the paper began with; but he (Major Malcolm) really was misled by the sentence which stated that the defence of the water approach to Richmond was entrusted to a single torpedo mine sunk in the channel way. He did not know how deeply Mr. Holmes had studied the

question, but there was a general vague idea that the thing would go off, and that a great many people would be killed, and people did not at all realise how much attention was necessary to an infinity of small points, nor how limited was as yet the utmost extent of our accurate knowledge.

Mr. HOLMES said that the defence of Richmond was entrusted to this single torpedo mine. That was the first mine laid in the river. The other torpedoes were laid closer up, and they did not come into action. The main defence was the large mine. There was no second mine put in the channel of the river to guard the approach.

Major MALCOLM said that the insulated cables of the marine torpedoes would be liable to get damaged by fishermen, if by no other means. The paper stated that by means of torpedoes places were to be defended beyond the range of cannon, and then when they came to handle the question a little bit, it was found that they were obliged to withdraw the torpedoes under the protection of cannon.

Mr. HOLMES explained the method of taking observations of vessels in connection with the torpedo system of defence. The arrangement was such that a torpedo would not be exploded unless a vessel was in position.

The CHAIRMAN, in closing the meeting, said that the discussion had been a very interesting one, and it might have been even more so if they had more practical details to deal with. A great many questions had been discussed that evening which, to telegraphers, were entirely novel and unknown. Telegraphy had, however, done one good thing for torpedo work. If he was rightly informed, it was a discovery made by Mr. Statham in manufacturing gutta-percha wires in 1851 or 1852, which gave an impulse to the igniting of mines by electricity. Sulphur was used with the gutta-percha, and, acting upon the copper, formed a coating of sulphide of copper. The passage of a very feeble current caused the ignition of this sulphide of copper, and created fire. Of course the platinum wire system was well known before this discovery was made by Mr. Statham.

A cordial vote of thanks was accorded to Mr. Holmes for this paper.

The Society then adjourned.

AN ordinary meeting took place on Wednesday evening last, the 11th inst., at the Hall of the Institute of Civil Engineers, Great George Street, Westminster. The chair was taken by Professor FOSTER, F.R.S.

A paper by Mr. J. J. FAHIE, Associate of the Society of Telegraph Engineers, Persian Gulf Telegraph, Kurrachee, on "*An Improved Double Current Telegraph Key*," designed by the author, was read by the Secretary.

A note on Mr. Latimer Clark's "*Method of Measuring Differences of Electric Potential*" was laid before the meeting by Professor ADAMS, of King's College.

A paper on "*Condensers in Connection with Duplex Telegraphy*," by Mr. R. S. CULLEY, was read by the Secretary.

A short discussion followed each communication. A summary of the papers and discussion is reserved for insertion in the TELEGRAPHIC JOURNAL of the 1st prox.

A paper on "*The Decay and Preservation of Timber for Telegraph Purposes*," by Mr. W. Langdon, was announced for the meeting to be held on the 25th inst.

TELEGRAPH WIRE.—Messrs. L. G. Tillotson and Co., of New York, have on exhibition a single piece of No. 8 galvanised iron wire, without joint or weld, which measures nine thousand nine hundred feet (nearly two miles). This piece of wire was manufactured by Messrs. Richard Johnson and Nephew, of Manchester, from a bar of their iron which was awarded the prize medal at the Vienna Exhibition.

Electrical Science in Foreign Journals.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences, Vol. lxxviii., No. 7.

Action of Fresh Water on Metallic Lead; Researches by the Electrolytic Method.—The author concludes (in general) that sulphuret of lead is soluble in fresh water, and also in water saturated with sulphuretted hydrogen; that the sulphuretted hydrogen does not show lead in a liquor, unless the metal is in certain quantity; that fresh river-water, more or less calcareous and gypseous, dissolves metallic lead; also that artificial calcareous or selenitous water does so, but in small quantity; that the St. Etienne water contains lead, but in harmless amount, &c.

On Relations which may Exist between Thermo-Electric Properties and Crystalline Form.—M. Friedel.—The author defends some of his views on the subject in opposition to the late M. Rose. He thinks that hemihedry with inclined faces may be regarded as connected with thermo-electricity in pyrites and cobaltine, but that this hypothesis of his does not appear demonstrable by crystallographic examination. "It is somewhat contradictory to suppose that the positive and negative varieties correspond to hemihedry right and left, which, in the case of hemihedry with parallel faces, are in no way distinguished, and that nevertheless these crystals may be recognised independently of the galvanometric test. If they were distinguished, they would no longer be symmetrical to one another. To give a sure support to this hypothesis (very plausible in itself, and the more attractive that we do not yet know any other physical property connected with hemihedry with parallel faces), it would be necessary to find thermo-electricity in other substances presenting the same hemihedry; unfortunately, crystals affected by it, and which are at the same time good conductors of electricity, are wanting."

No. 8.

On the Permanent Magnetism of Steel.—M. Bouty.—Consider two bodies, A and B, submitted to the same inductive force, but invariably bound together. After cessation of the force, A remains subject to the action of B, and preserves, besides the residual magnetic moment which would remain with it after removal of A, a moment of the same or of contrary direction, produced by influence of B, and which is permanent only so long as the connexion between A and B subsists. This magnetic excess might be called the *sub-permanent magnetic moment*. In the experiment of a bundle ruptured parallel to the axis, the sub-permanent magnetism is of the contrary direction to the permanent magnetism. It would be in the same direction in the case of a cylindrical needle broken perpendicular to its axis, and the two fragments of which were separated or placed end by end. This is confirmed by experiment.

Les Mondes. Vol. xxxiii., Feb. 19.

Thermo-Electric Pile of M. Clamond.

Facts of Electricity.—Prof. Candido.—The author has been experimenting on the deflection of astatic needles by thermo-electric currents, and he describes here some curious phenomena noticed "by the way." He had a platinum needle mechanically joined (parallel) to the astatic system, but insulated from it. With a certain deflection, this needle came into contact with two opposite vertical wires of platinum, thus closing a circuit, and causing a bell to ring. Now when this contact occurred, the platinum needle remained as if held by the vertical wires. To detach it, the restituent force of the astatic system did not suffice, nor that of

a Daniell battery current sent through the galvanometer in such a direction as to move the needles back. The contact continued, too, when the current no further circulated through the needle and vertical wires. The author supposes that the platinum needle has a continuous minute vibrating movement, in which there are repulsions produced by the circulating current; the needle being repelled, there are opposite polarities at the points of previous contact, giving rise to an attraction and fresh contact, and so on. Another phenomenon is this:—An iron wire terminating a rheophore from a strong Bunsen battery is put in mercury held in a copper capsule, connected by copper wire with the other pole. A succession of bright sparks appears in the mercury, indicating discontinuity and repulsion, with alternate attraction. The wire is heated and softened, a small pellicle being formed which at length suddenly explodes. Some other movements of attraction are described. Globules of mercury in a vessel of acidulated water were attracted towards a larger mass of mercury at the one side, when one rheophore was put in this mass and the other in the water.

Feb. 12 and 26.

These two numbers contain no papers on electricity.

Revista de Telegrafos. February 1, 1874.

Spanish Telegraphy in 1873; Reform and Extension of the Telegraphic System.

Experiments on the Electric State of Conductors on the Italian Lines.—Some new regulations have lately come into force, according to which the inspectors of stations are required to examine once a month the conductivity and insulation of lines terminating at their stations or passing through them, and to report to the departmental directors, who forward a copy (of the report) to the general direction. The data thus collected are compared by the latter with the conditions of a line in the normal state, and with psychometric and thermometric changes, and the result is shown in graphic curves. The testing experiments are made with a galvanometer having 1000 turns of wire, with whatever rheostat the inspector may have, and with a battery of 50 Bunsen elements. The mode of interpreting the indications is fully explained.

February 15.

Decrees and Regulations Relating to Telegraphy.—(To the new cables about to be laid from Spain to Havana, and from Bilbao to Santander; and to the transference of members of the telegraphic service from Spain to foreign provinces, their status in these, and their return).

Spanish Telegraphy in 1873 (continued); Establishment of the Electro-Semaphoric Service.—The Commission appointed thought it desirable to establish semaphoric stations immediately at the following points:—Tarifa, Cape of San Antonio, Cape Villano, Cape of Penas, Barcelona, and Cadiz. As yet, only one has been equipped—at Tarifa, in June last.

Buletino Telegrafico. December, 1873.

(Official Part).—Among the points here treated are the conditions of admission to the telegraphic service in Italy.

(Unofficial Part).—*Construction and Immersion of Submarine Telegraph Cables; Static Electricity.*—(Some observations, by Professor Volpicelli, to the R. Accademia dei Lincei on the static effects of the Coulomb balance).

Reale Istituto Lombardo di Scienze e Lettere. Rendiconti. December 18, 1873.

On the Polarisation of Non-Conductors.—M. Cantoni.—Concluding portion of a valuable controversial

paper, in which the author discusses objections raised by Professor Righi to his opinion as to the possibility of polarising non-conductors in a durable way.

City and Commercial Notes.

THE Electric Power Company is the title of a new undertaking which has been privately subscribed, for the purpose of taking over the patent for Gramme's Magneto-Electric Machine. The immediate objects of the Company are the economic development of electrical power, more especially in its application to telegraphy, electro-plating, electric chucks, electric light, railways, and the production of chemically pure copper, aluminium, caustic soda, &c.

The West India and Panama Telegraph Company have received intelligence through their engineer, Sir Samuel Canning, of the complete restoration of the section of their cable between Martinique and Dominica, thus reopening for traffic the whole of the lines from Cuba to Demerara. The interruption on the Cuba Company's cable is now the only obstacle to direct telegraphic communication with the West Indies, and it is hoped that this cable will be completed shortly.

The receipts of the Eastern Extension, Australasia, and China Telegraph Company (Limited) for the month of February amounted to £17,706, against £18,085 in the corresponding period of 1873, from the four separate lines, viz., the British Indian Extension, China Submarine, British Australian, and the Victoria and Tasmanian Telegraph.

The traffic receipts of the Great Northern Telegraph Company during February amounted, on the European lines, to 173,235 francs against 109,415 francs in 1873; and on the China and Japan lines, to 114,859 francs against 79,680 francs in 1873.

The receipts of the Submarine Telegraph Company for the month of February amounted to £7800 against £7616 for the corresponding month of 1873.

The Eastern Telegraph Company's traffic receipts for the month of February amounted to £31,084, against £30,284 in the corresponding period of 1873.

We understand that the Indian Government have given notice that illegitimate compound words, which have hitherto been tolerated in messages, will not in future be allowed. The Indo-European Telegraph Company (Limited) has printed a list of combinations, among others, which will be charged for according to the number of words represented. If accepted through oversight of the postal counter clerks, the senders will understand that there is great risk of their messages being delayed until the number of words is corrected and the right charge collected. Combinations of numerals in the English language will be counted according to the number of words used to express them. Made-up words will be counted the same as cyphers. The following is an extract from the *Indian Government Telegraph Gazette* of the 6th of January, 1874:—"The attention of the Bureau International des Administrations Télégraphiques having been directed to the increasing frequency of the practice of joining together words which do not admit of such combination, it has been decided that any telegraphic administration over whose lines a message passes has the right to demand that the cost of extra words chargeable shall be recovered from the sender, and credited in the International accounts. 2. In accordance with Article 49 of the Rome convention, and with the notice printed on the back of receipts for foreign messages, undercharges are recoverable from the sender. 3. *Webster's Dictionary* has been adopted as the standard for all English words. Words separated by a hyphen in that *Dictionary* are regarded as so

many separate words, and only those written continuously, without space or hyphen, can be accepted as single words." Reuter's Telegram Company have memorialised the Indian Telegraph Department on behalf of the public generally to relax the stringency of the rules in question. But, as the secretary remarks, it is not surprising that the Department should now enforce stricter regulations when such combinations as "Fireinsurancepolicy," "Pigirontons," "Wireanswer," and the like, are tendered for transmission as single words.

At the meeting of the Mediterranean Extension Telegraph Company (Limited), held on the 9th inst., the report was adopted. It stated that the receipts for messages during the past half-year amounted to £4869, the net receipts to £3068, and the expenses for the same period to £1800. A dividend at the rate of three per cent per annum was declared, leaving £491 to be carried to the reserve, which will then amount to £6256.

TELEGRAPH SHARE LIST.

Amount per Share.	NAME OF COMPANY.	Amount paid up.	Closing Quotations.
£		£	Mar. 12.
Stock	Anglo-American (Limited)	100	80-80½
10	Brazilian Submarine	9	3-2½ dis.
10	Cuba	All	7½-7½
10	Direct Spanish	9	—
20	Direct United States Cable	17	5½-4½ dis.
10	Eastern (Limited)	All	7½-8
..	Do., New	—	—
10	Eastern Extn. Australia and China	All	7½-8½
10	Globe Telegraph and Trust	All	7-7½
10	Do., 6 per cent Pref.	All	98-98½
10	Great Northern	All	98-10
25	Indo-European	All	10-17
10	Mediterranean Extension (Limited)	All	4-4½
10	Do., 8 per cent Pref.	All	11-12
10	Panama and South Pacific	2½	— dis.
8	Reuter's	All	11-11½
Stock	Submarine	100	230-240
1	Do., Scrip	All	2-2½
10	West India and Panama	All	5-5½
10	Do., 10 per cent Pref.	All	98-98½
20	Western and Brazilian (Limited)	All	11-12
1000 dls.	West Un. U.S. 7 per cent 1st M.B.	All	105-107
10	Hooper's Telegraph Works	All	11½-12½
50	India-Rubber and Gutta Percha	All	24-26
Cert.	Submarine Cables Trust	100	108-110
12	Telegraph Construction	All	30-30½
100	Ditto Ditto 7 per cent Bonds	All	101-103

Patents.

UNITED STATES.

143,663. R. K. Boyle, New York. *An Electric Apparatus for Signalling between Railway Trains.* Dated August 28, 1873.—Arrangement of circuits, &c., substantially same as in Boyle's patent of August 12, 1873, substitutes soft iron forked armature for polarised armature of that patent in the switching devices.

143,679. T. B. Doolittle, Bridgeport, Conn. *Electric Vote Annunciator.* Dated July 28, 1873.—Circuit closing key at each desk, swinging numbered plate in a frame corresponding to each desk. Closing key allows plate to fall, and at same time releases a ball, which rolls into a graduated glass tube. Secondary apparatus at another point may be put into same circuit, so as to announce vote at a distant place.

143,691. J. H. Guest, Brooklyn, N. Y. *Electrical and Thermostatic Fire Alarm and Circuit therefor.* Dated September 1, 1873.—Circuit breaker in a normally closed circuit revolved by clockwork controlled by a thermostat. Series placed in ordinary closed circuit without interfering therewith.

143,702. L. T. Lindsey, Jackson, Tenn. *Printing Telegraph.* Dated May 3, 1873.—Synchronism maintained by devices which break circuits of fastest going instruments until all have reached a designated letter or space.

DIRECT UNITED STATES CABLE COMPANY.—A number of gentlemen recently visited the works of Messrs. Siemens, at Charlton, to inspect the cable which is being manufactured for this company. The core of the cable is made upon a new principle, offering a surface smaller than has been adopted heretofore; thus securing a decreased inductive capacity. The cable itself is heavier than any that have yet been laid, and the shore ends will be sunk in deeper water, thereby lessening the risk of danger from passing vessels. The new cable will be laid in June, the starting point from the side being near Valentia. The other end will be beached on Newfoundland, carried across to Nova Scotia, and thence to New Hampshire. Messrs. Mitchell and Co., of Newcastle, have nearly completed the building of the steamer *Faraday* specially designed for the laying of the cable. On the 17th ult. there was a numerous gathering in the extensive iron-ship building works of this firm to witness the launch of the new cable steamer. The *Faraday* is 360ft. long, 52ft. beam, 36ft. deep, and measures about 5,000 tons gross register. She will, however, carry about 6,000 tons dead weight. The iron hull has been built under the inspection of Lloyd's agents, and will be accorded the highest certificate of classification. In addition to the usual requirements of Lloyd's rules, the *Faraday* receives an enormous additional strength from her peculiar structure. This consists chiefly of three enormous cable tanks constructed of plate-iron, and forming a series of double arches supporting the sides of the vessel. These tanks are also united together and to the general fabric of the hull by five iron decks; the upper and main iron decks are supplemented by the usual decks of wood for the comfort and convenience of those on board. This vessel is double-bottomed, the space between the two bottoms being a network of iron girders for carrying the cable tanks, and at the same time giving longitudinal strength to that portion off the hull. The space is further utilised for carrying water ballast to trim the vessel as the cable is run out, and also to enable her to make a voyage across the Atlantic without any cargo or other weight on board beyond fuel. A very complete and well-devised system of valves, cocks, pipes, and auxiliary engine-power has been introduced into the vessel for filling and emptying any single compartment of the double bottom, or for flooding any one of the cable tanks. The whole system is under the control of the engineers, and is worked from the engine-room. In outward appearance the *Faraday* is unlike other ocean steamers by her bow and stern being of the same form. She is also provided with a rudder at each end, the whole being so arranged that the vessel may be navigated ahead or astern as may be desired when paying out or picking up a cable. The steering is accomplished by means of a steam-engine placed amidships, and to provide against accident each rudder is supplied with strong screw steering gear worked in the usual manner by manual power. The anchors and cable chains are worked by Harfield's steam windlass, and all heavy labour about the vessel is performed by steam apparatus placed in various positions along the deck. The *Faraday* will be rigged in the most approved manner of ocean steamers, and for the accommodation of the large staff of officers, electricians, and crew, amounting to about 150 persons, the vessel will be fitted up with all the cabins and other appliances of a large passenger steamer, in addition to the multifarious appliances of a cable ship. The *Faraday* will be propelled by machinery on the compound surface-condensing principle manufactured by Messrs. T. Clarke and Co., of Newcastle. There will be two distinct sets of engines, each working a separate screw, the vessel being provided with two propellers, usually called twin screws. The object of this arrangement is to obtain

increased steering or manœuvring power, which is a very important condition in cable laying. Each set of engines is placed vertically over the shaft, and has two cylinders, one high pressure and the other low pressure, by which great regularity of motion is obtained, and by a high degree of expansion in working the system an important economy of fuel is effected. By these means this great vessel is enabled to carry her immense burden of cable at an expenditure of fuel which would have seemed impracticable but a very few years ago. The deck machinery required for paying out and picking up cables is being manufactured by the Vulcan Foundry Company, who have had great experience in this kind of work.

THE INTERNATIONAL EXHIBITION, 1874.—This year the Commissioners of the International Exhibition have made special efforts to enlist the active assistance of all industrial corporations, companies, schools, and producers in their desire to promote technical instruction. As this can only be effected by securing the presence at South Kensington of the artisans themselves, it has been resolved to issue packets of artisans' tickets and school tickets at a cheap rate for gratuitous circulation, the purchaser of the packets to receive in return a season ticket and membership of the Association. Such artisans' and school tickets will be available or use on Saturdays and Mondays during August, September, and October. In pursuance of their original design, while fine Arts and other divisions remain year by year, a material change annually occurs in other subjects. For 1874, the programme is in many respects superior to any of the previous Exhibitions of the series. On the list of new classes may be mentioned Mechanical and Civil Engineering. The fourth meeting of the Committee for Scientific Inventions and New Discoveries was held at the Royal Albert Hall, on the 3rd inst.; Mr. J. Ramsbottom in the chair. There were also present Mr. F. A. Abel, F.R.S., Captain Hans Busk, Major W. Crossman, Sir Eustace Piers, Bart., Dr. D. S. Price, and Mr. T. Sopwith. Captain E. G. Clayton, R.E., attended. The Committee considered the applications that had been received, and directed that letters should be written to a number of the applicants stating that the objects they propose to exhibit are inadmissible. The Committee adjourned until the 17th inst.

To Correspondents.

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Cheques and Post Office Orders to be made payable to HENRY GILLMAN, and to be crossed "London and County Bank."

ALL SUBSCRIPTIONS PAYABLE IN ADVANCE.

C. SMITH.—Our space will not admit of a reply to the number of questions you ask. The machine and other instruments to which you refer will shortly be described in our pages. We have already given some of the information you require in our Almanack for 1874, and in back numbers of the Journal.

C. O., jun.—The cutting you send us from a contemporary contains some errors. We referred to the facts in our issue of January 15; as soon as our space will allow, we shall return to the subject. The rates for foreign postage were inserted in our issue of Feb. 15, and are now repeated.

J. C. RIEFF (New York).—Thanks for your communication. We will look into the matter.

E. B.—In our next.